

Periodo de Concentración
Quantum Information and Quantum Many Body Systems
October 2008

$$|\psi\rangle = \sum_{i_1 \dots i_n} \text{tr}[A_{i_1} A_{i_2} \dots A_{i_n}] |i_1 i_2 \dots i_n\rangle$$

Having a quantum information point of view has been proven extremely successful when it comes to understand the behavior of Quantum Many Body Systems. This has been done mainly through the different variants of Tensor Network States: MPS, PEPS, MERA, ... These states are characterized by the fact that the relevant quantities one is interested in: amplitudes, expectation values of local observables, correlation functions, ... can be computed through the contraction of a suitable graph of tensors, usually related to the interactions between the parties. Tensor Network States has given us a deeper insight in the behavior of Quantum Many Body Systems from both a numerical and analytical point of view. In numerics, they provide with variational algorithms, like DMRG, which are in practice extremely precise. But they also allow us to understand in a clearer way many intriguing phenomena, as for instance: One-way Quantum Computation, Quantum Phase Transitions, Topological Order or Entanglement.

From a mathematical point of view, the variety of techniques used upon to now to treat them is extremely rich: Graph Theory, Stochastic Processes, Functional Analysis, Complexity Theory, Group Theory, ... but the most interesting thing is that, perhaps, this area could motivate the introduction of completely new mathematics, specially adapted to it. One-way Quantum Computation, Quantum Phase Transitions, Topological Order or Entanglement.

Key words: Quantum Information, Quantum Many Body States, Tensor Network States, MPS, PEPS, MERA, One-way Quantum Computation, Quantum Phase Transitions, Topological order, Entanglement

Responsables del periodo de concentración:

David Pérez García.

Activities:

COLLOQUIUM

- *An introduction to Tensor Network States for non-specialists* TBA
- Intensive Period on *Quantum Information and Quantum many Body Systems*
J.I. Cirac (Max Planck Institute of Quantum Optics, Garching, Germany).

PHD-ORIENTED MINI-COURSE

- *An introduction to quantum information, quantum computation and quantum many-body systems* 6 - 10 october 2008
- Intensive Period on *Quantum Information and Quantum many Body Systems*
David Pérez-García, Universidad Complutense de Madrid.

ADVANCED WORKSHOP

Theoretical Aspects of Tensor Network States

Intensive Period on *Quantum Information and Quantum many Body Systems*

Organizing Committee: J.I. Cirac (MPQ, Garching), D. Pérez-García (UCM), F. Verstraete (Viene University), M.M. Wolf (Niels Bohr Institute, Copenhagen).

Confirmed invited participants: B. Bauer (ETH), S. Bravyi (IBM), J. Eisert (Imperial Colleg), J. García-Ripoll (CSIC), M. Hastings (Los Alamos NL), R. Huebner (Innbruck), S. Iblidir (Barcelona), J.I. Latorre (Barcelona), J. León (CSIC), M.A. Martín-Delgado (UCM), I. McCulloch (Queensland), V. Murg (MPQ), T. Nishino (Kobe), R. Orús (Queensland), A. Sandvik (Boston), M. Sanz (MPQ), N. SCHUCH (MPQ), U. Schollwock (Aachen), M. Troyer (ETH), X-G. Wen (MIT).

15 - 18 october
2008

Confirmed visitors:

- Román Orús, Queensland (Australia), 13-23 october 2008

Research Groups involved:

2.3 MATEMÁTICAS E INFORMACIÓN QUÁNTICA.

Responsables: David Pérez-García

Sponsors:

